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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/613,610	07/03/2003	Elan Yogeswaren	PAT023US	7309

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EXAMINER	
GARBER, CHARLES D	
ART UNIT	**PAPER NUMBER**
2856	

DATE MAILED: 05/10/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Ak

Office Action Summary	Application No.	Applicant(s)	
	10/613,610	YOGESWAREN, ELAN	
	Examiner	**Art Unit**	
	Charles D. Garber	2856	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _15 April 2005_.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1-84_ is/are pending in the application.

4a) Of the above claim(s) _12-21,33-80,83 and 84_ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _1-7,9-11,22-32,81 and 82_ is/are rejected.

7)☒ Claim(s) _8_ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on _03 July 2003_ is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _7/3/03,9/27/04_.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

Claims 12-21 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected species, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on 04/15/2005.

Claims 33-80, 83 and 84 were previously withdrawn as being drawn to a nonelected invention, which leaves claims 1-11, 22-32, 81 and 82 to be considered on the merits.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1, 2, 4, 5, 9-11, 22, 25-32, 82 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dowell et al. (US Patent 5,899,958) in view of Smith, W. A.,

(Paper titled “New opportunities in ultrasonic transducers emerging from innovation in piezoelectric materials”, SPIE Vol. 1733 (1992), 3-26, from Applicant’s IDS).

Regarding claims 1, 5, 9, 29, Dowell discloses a logging while drilling borehole imaging device (title) considered equivalent to a downhole measurement tool as in the instant invention. Figures 1 and 3 show a substantially cylindrical tool body (tool 50). A cylindrical body by definition inherently possesses a cylindrical axis. Items 205, 215, and 225 shown in figure 3 are ultrasonic sensors deployed on the tool body. Ultrasonics is considered to be a rather broad undefined range within acoustics and is considered therefore to anticipate acoustics. Figure 5 shows the ultrasonic sensor including a piezoelectric crystal transducer (e.g. sending and receiving) element with anterior and posterior faces. Figure 6 shows a electrical block diagram depicting the piezoelectric transducers in electrical communication with a downhole CPU (no item number) which is considered to be equivalent to an electronic control module. The lines connecting the items are considered to be equivalent to conductive electrodes.

Dowell does not expressly teach the piezoelectric transducer is a piezo-composite transducer element including regions of piezoelectric material deployed in a matrix of a substantially non-piezoelectric material, the regions extending through a thickness of the transducer element in at least one dimension. Dowell also does not expressly disclose the electrodes disposed on each of the element faces

Smith teaches this configuration on pages 9-17 in a section headed “4. PIEZOELECTRIC COMPOSITES”. Various arrangements are shown in figure 1 but figure 2 shows a matrix arrangement of pillar or columnar piezo elements described “as

the most promising candidate" for a "PZT-rod/polymer-matrix composite". The regions of piezoelectric material may be described as a periodic array of spaced piezoelectric material posts. The polymer that fills the space between the PZT rods is considered to be a substantially non-piezoelectric material as in the instant invention. The rods appear to extend through the thickness of the matrix. Smith also teaches the electrodes disposed on each of said faces (page 10).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to us a piezo-composite transducer element including regions of piezoelectric material deployed in a matrix of a substantially non-piezoelectric material, the regions extending through a thickness of the transducer element in at least one dimension. This most promising arrangement offers the advantage of "broad bandwidth and short ringdown times as well as low crosstalk between the individual elements (section 4.3 on page 14). Furthermore, it would have been obvious to one having ordinary skill in the art at the time the invention was made electrodes disposed on each of said faces in order to produce an extensional pulse in the piezoelectric material and thereby produce an acoustic wave emanating from the face of the device. The same reasoning applies for the complimentary process of monitoring the return echo response.

As for claim 10, Smith, in section 4.1 (page 10) further teaches steps (a) providing a solid [piezo] ceramic disk having first (top as shown in figure 3(a)) and second (bottom as shown) faces, step (b) cutting a first set and step (c) a second set of grooves in the first face, the grooves in the first set being substantially orthogonal

(perpendicular or at right angles as shown) to the grooves in the second set. The removal of piezo-ceramic material in the groove cutting is considered inherently operative to shape the piezoelectric material posts. Step (d) teaches casting the polymer material into the grooves to form, in combination with the piezo-ceramic disc, a specimen of piezo-composite material after step (e) and a repeat of cutting steps. The device after step (h) has first and second faces corresponding substantially to those of the piezo-ceramic disk. Smith discloses an alternative embodiment ascribed to Savakus that deletes the repeated step of right angle cuts on the opposite side and instead grinds the uncut side to produce through thickness PZT elements and polishing the specimen to a final thickness. A final thickness is considered to be predetermined. As discussed above Smith also teaches disposing conductive electrodes on each of the first and second faces of the specimen.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to follow this process of cutting the pillars from a single piece of piezo ceramic material as the obvious alternative of assembling the matrix from plural individual pillars would be very time consuming and very difficult to maintain proper spacing. Examiner is unaware of any other alternative for forming such devices.

As for claim 2, Smith, in section 2.2 (page 5) teaches the piezoelectric material may be lead zirconate titanate as in the instant invention alternative.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use lead zirconate titanate because of its "strong piezoelectric effect", the ability to adjust its properties by varying material proportions, and its

"exceedingly high electromechanical coupling coefficients", which "commend these ceramics for a vast array of applications".

As for claim 4, Smith teaches PZT piezoelectric material has a coupling coefficient as high as 80% (0.8) (see section 2.2 of Smith) which is greater than about 0.3. This produces a very efficient and sensitive sensor in application and as discussed above, commends PZT for a vast array of applications.

As for claim 11, a sectional view of the Smith transducer element shows a laminate including alternating layers of the piezoelectric material and the non piezoelectric material. The Smith structure is advantageous for the reasons given above.

As for claim 25, Dowell discloses three ultrasonic sensors as shown in figure 3, each including piezoelectric transducer elements. Smith suggested the advantage of such elements being of a composite structure as discussed above.

As for claim 26, Dowell figure 3 also shows the tool 50 body has a periphery, and wherein the three sensors 205, 215 and 225 are disposed substantially equidistantly about the periphery of the tool body.

As for claim 27, as discussed above, the CPU is "downhole" in the imaging assembly 202 within the tool body (figure 2).

As for claims 28 and 82, since the tool is used while drilling Examiner considers it is inherently part of and therefore couplable with a drill string. Specific to claim 82, Dowell's figure 5 shows item 60 which is the sensor operating to transmit and receive acoustic signals in a borehole.

As for claim 22, Examiner takes Official Notice that use of conductive electrodes comprising gold is widely known in the art of electronics. It would have been obvious to one having ordinary skill in the art at the time the invention was made to use gold electrodes which are highly conductive and corrosion resistant.

As for claim 30, figure 5 of Dowell shows the piezoelectric crystal element as a laminate including a "backing" layer deployed nearer to the cylindrical axis from the crystal.

As for claim 31 and 32, figure 5 of Dowell shows the piezoelectric crystal element as a laminate including a layer deployed further away from the cylindrical axis than the piezo-composite transducer. The layer may be considered to be matching the crystal as it fits together with it. Matching may be defined as "to fit together or make suitable for fitting together" according to the Merriam-Webster Online Dictionary. The same layer appears structurally to function effectively as a barrier and it is on an outermost surface of the laminate furthest away from the cylindrical axis.

Claims 3, 81 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dowell et al. (US Patent 5,899,958) as modified by Smith, W. A., (Paper titled "New opportunities in ultrasonic transducers emerging from innovation in piezoelectric materials", SPIE Vol. 1733 (1992), 3-26, from Applicant's IDS) and applied to claim 1 above and further in view of Helke (US Patent Application 2005/0006620) and Taniguchi et al. (US Patent 6,272,916).

Regarding claim 3, 81, the references do not expressly teach the piezoelectric material has a Curie temperature greater than or equal to about 250 degrees C.

Helke teaches piezoelectric ceramic materials based on lead zirconate titanate (PZT) with a perovskite crystal structure having a curie temperature at least 343° C (see tables in paragraphs 0020, 0024 and 0031). Helke does not explain what benefit in terms of application may be obtained with materials having the particular structure and consequent high curie temperatures, however, Taniguchi teaches a problem with some piezoceramic materials is their low curie temperature of about 120° C (column 2 lines 57-62) which is too low to withstand elevated temperatures in the vicinity of the bottom of the borehole where temperatures can reach 175° C (column 8 lines 21-23). Taniguchi suggests an oscillator material should be chosen capable or resisting such a high-temperature environment (column 8 lines 30-34).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to choose Helke's piezoelectric material with a structure providing curie temperatures well above 250° C as this would be capable of resisting the high temperature environment at the bottom of a borehole according to Taniguchi.

Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dowell et al. (US Patent 5,899,958) as modified by Smith, W. A., (Paper titled "New opportunities in ultrasonic transducers emerging from innovation in piezoelectric materials", SPIE Vol. 1733 (1992), 3-26, from Applicant's IDS) and applied to claim 1 above and further in view of Millar et al. (US Patent 6,236,144)

Regarding claim 6, the references do not expressly teach the polymeric material is an epoxy resin.

Millar teaches a composite sensor structure of "piezoelectric material" of "ceramic such as lead zirconate titanate (PZT)" where "[t]he matrix is a polymer such as epoxy resin. It provides rigidity to the piezoelectric material for ease of handling during manufacture and ruggedness in use."

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use a polymer such as epoxy resin because it provides rigidity to the piezoelectric material for ease of handling during manufacture and ruggedness in use.

Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dowell et al. (US Patent 5,899,958) as modified by Smith, W. A., (Paper titled "New opportunities in ultrasonic transducers emerging from innovation in piezoelectric materials", SPIE Vol. 1733 (1992), 3-26, from Applicant's IDS) and applied to claim 5 above and further in view of Erikson et al. (US Patent 6,776,762).

The references as applied above do not expressly teach the polymeric material has a coefficient of thermal expansion less than about 100 parts per million per degree C.

Erikson teaches the polymer matrix between piezo elements in a piezocomposite should have a low thermal expansion in order to minimize the differential expansion between the composite array and the attaching electrode support structure. Erickson gives examples of using epoxy with thermal expansion of 40 parts per million per degree C and silicon with 7 parts per million per degree C (column 3 line 49 to column 4 line 13).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have a coefficient of thermal expansion less than about 100 parts per million per degree C such as by using epoxy or silicon because the lower the thermal expansion the lower the differential expansion between the composite array and the attaching electrode support structure thereby reducing the chance of electrode failure.

Claims 23 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dowell et al. (US Patent 5,899,958) as modified by Smith, W. A., (Paper titled "New opportunities in ultrasonic transducers emerging from innovation in piezoelectric materials", SPIE Vol. 1733 (1992), 3-26, from Applicant's IDS) and applied to claim 1 above and further in view of Birchak et al. (US Patent 6,354,146).

Figure 5 of Dowell shows an EPOXY housing surrounding the crystal sensor element and backing 45 but the references do not expressly teach a pressure equalization layer disposed on an interior surface of the housing with silicon oil.

Birchak discloses acoustic transducers for well production which at figure 7 shows sensor element 102 with backing 110 in a housing 120 further teaching a layer 103 within the housing composed of "liquid having good acoustical properties, such as silicone oil". Birchak further teaches "Because the hydrostatic pressure of the fluid in the production tubing (i.e. outside the transducer housing) fluctuates with depth and in response to variations in pressure at the surface and variations in fluid weight, the volume of the fluid inside housing 120 needs to fluctuate so as to maintain a pressure balance. The pressure balance is needed if any component of the transducer, such as

the backing, permanently deforms under pressure. In the present device, variations in fluid volume are achieved by flexing of corrugated sleeve 124. Fluctuations in hydrostatic pressure are matched by expansions or contractions of the fluid surrounding transducer 102 and corresponding movement of sleeve 124, thereby allowing hydrostatic pressure to remain equal inside and outside the housing."

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a pressure equalization layer disposed on an interior surface of the housing with silicon oil to prevent permanent deformation of the backing.

Allowable Subject Matter

Claim 8 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter:

The references do not expressly teach the polymeric matrix material in composite array devices having a glass transition temperature [Tg] of greater than about 250 degrees C.

Lukasiewicz et al. (US Patent 5,038,069) teaches "bonding material" used in a piezoelectric sensing device "is selected to have a glass transition point within the temperature range of intended use" otherwise the material will loose its rigidity and the device will no longer work effectively.

As discussed above, Taniguchi teaches a problem with some piezoelectric materials is their inability to withstand elevated temperatures in the vicinity of the bottom of the borehole where temperatures can reach 175° C (column 8 lines 21-23). Taniguchi suggests an oscillator material should be chosen capable or resisting such a high-temperature environment (column 8 lines 30-34).

However, this combination would only suggest using polymers with Tg around 175° C rather than about 250 degrees C as in the instant invention.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Charles D. Garber whose telephone number is (571) 272-2194. The examiner can normally be reached on 6:30 a.m. to 3:00 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Hezron Williams can be reached on (571) 272-2208. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

cdg

CHARLES GARBER
PRIMARY EXAMINER